The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 57
April
1922
No. 675

LONDON : PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses :
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1;
37, PETER STREET, MANCHESTER ; 1, ST. ANDREW'S CRESCENT, CARDIFF; 23, FORTH STREET,
EDINBURGH ; EASON AND SON, LTD., 40 and 41, LOWER SACKVILLE STREET, DUBLIN ;
or from THE METEOROLOGICAL OFFICE, SOUTH KENSINGTON, LONDON, S.W. 7.

Weather Prediction by Numerical Process: A Review of Mr. Richardson's Work.

BY F. J. W. WHIPPLE, M.A.

Weather Prediction by Numerical Process, the remarkable book which has been written by Mr. L. F. Richardson, formerly Superintendent of Eskdalemuir Observatory, now lecturer at the Westminster Training College and one of the Honorary Secretaries of the Royal Meteorological Society, is devoted to the question whether the forecasting of weather by arithmetical methods of a particular type is possible. The astronomer can forecast the position of the moon years ahead with the greatest precision, why should not the meteorologist predict the weather with like accuracy? It is true that the meteorologist has to take into consideration many more factors, for if you begin to think how the weather of to-morrow is determined by the weather of to-day, you will realise that the mere specification of the weather of to-day is a complicated business. To-day's weather in the widest sense includes not only the distribution of pressure, wind, temperature, humidity and cloud amount all over the globe and at all heights, but also the intensity of radiation from the sun, the temperature of the sea, the state of the ground, the extent of ice and snow, and the rate of evaporation of moisture from trees and other vegetation.

Mr. Richardson is not dismayed by the length of this list. He deals with each factor in turn and shows how the contribution

Weather Prediction by Numerical Process. *By* Lewis F. Richardson, B.A., F.R.Met.Soc., F.Inst.P., 4to, 11¼ × 8½, xi + 231 pp., *diagrams.* Cambridge : University Press, 1922. 30s. net.

x (64)17375 Wt 105—P 35 1000 4/22 E & S A 2

of each factor to the changes in progress may be assessed with more or less accuracy and how the corresponding differential equations may be built up.

Before he went to Eskdalemuir and turned his attention to meteorology, Mr. Richardson had devoted much attention to the solution of problems in applied mathematics by numerical processes. The mathematician when confronted with a physical problem usually simplifies the conditions so as to make it amenable to his analytical machinery. The sledge-hammer method developed by Mr. Richardson requires no such preliminary paring down of awkward corners: it demands, however, conscientious attention to detail and no shirking of laborious arithmetic.

The scheme contemplates the tabulation and computation of the meteorological elements at some 2,000 stations distributed regularly over the globe. The stations are to be at the centre of " squares " in a chessboard pattern. For the black " squares " certain elements such as pressure are computed, for the white " squares " others such as the strength and direction of the wind at various heights. Each computation starts with the weather of one instant and determines that three hours later. Judging by his own experience, Mr. Richardson allots thirty-two computers to each pair of stations. He does not seem to have allowed sufficiently for the increased speed of routine computation as compared with pioneer work, but on the other hand his computers are working day and night. We must multiply the number by three to provide for shifts. Moreover, he does not allow for the revision of the forecast as later information comes to hand. There should be an advance guard forecasting, say, six months ahead, another division forecasting three months ahead and others, perhaps, one month and one week ahead. Taking these requirements into consideration we cannot keep the number below 50,000. Moreover, even if the scheme were perfected, the really interesting weather would not be forecasted, for thunderstorms and tornadoes as well as the secondary features of the cyclones of the temperate zone would be " smoothed out " in the highly generalized specification of the meteorological situation.

In view of this criticism, which, it is fair to say, is put forward by Mr. Richardson himself, it hardly matters that the one forecast six hours ahead at one place, which he has computed, is sadly in error.

The trouble which he meets is that quite small discrepancies in the estimate of the strengths of the winds may lead to comparatively large errors in the computed changes of pressure. It is very doubtful whether sufficiently accurate results will ever be arrived at by the straightforward application of the principle of the conservation of matter. In nature any excess of air in

one place originates waves which are propagated with the velocity of sound, and therefore much faster than ordinary meteorological phenomena.

One of the difficulties in the mathematical analysis of pressure changes on the earth is that the great rapidity of these adjustments by the elasticity of the air has to be allowed for. The difficulty does not crop up explicitly in Mr. Richardson's work, but it may contribute to the failure of his method when he comes to close quarters with a numerical problem.

The value of the book is not, however, to be judged by this failure. Its merit is that it insists on the study of all the various ways in which the meteorological elements act and re-act on each other. This co-ordination of knowledge has been the stimulus to many special researches valuable in themselves but appearing now, for the first time, in their proper relations.

Meteorology is largely occupied with the consideration of eddies and whirls. Mr. Richardson parodies an old quip with the jingle,

> " Big whirls have little whirls, which feed on their velocity;
> And little whirls have lesser whirls, and so on to viscosity,"

and in his analysis of the dynamical conditions he brings out how the apparent viscosity of the air differs according to the scale of the phenomena. He considers that the interlacing of air currents on a large scale, as shown, for example, by the variation in the tracks of balloons in a Gordon Bennett race, indicate that the great currents across wide stretches of land must re-act on each other as if they had a viscosity far greater than that of treacle.

Whether our methods of forecasting are gradually developed from the present practice, or whether an entirely new system, such as the author's, is invented, he has done good service by helping meteorologists to obtain a clearer insight into the operation of the forces with which they deal.

The comprehensive scheme of this book should make it a useful work of reference. In this connection the list of symbols in Chapter 12 must be mentioned. Having exhausted the characters of our own language and of Greek, the author introduces novel symbols, some borrowed from Coptic, some with no names at all. For each symbol the interpretation is given in the international language Ido as well as in English. The publication of this list will facilitate the adoption of a standard notation for meteorological calculations. The actual demonstration of how a notation can be used consistently throughout a book covering such a wide field is preferable to much discussion by committees.

There is nothing new to say about the excellence of the work of the Cambridge University Press, the reviewer can only commend it to the notice of all readers of this book.

Official Publications.

Weather Forecasting in the Eastern North Atlantic and Home Waters for Seamen. By Commander L. A. Brooke Smith, R.D., R.N.R. $9\frac{1}{2} \times 6$, 24 pp., illus., 1921. Price 6d.

The object of this pamphlet is to instruct seamen in the methods by which the reports received by wireless telegraphy from the transmitting station at Poldhu and from other ships may be utilised. Examples showing how a map may be constructed and used for forecasting are set out in detail. Such maps will soon be regarded as essential for safe navigation. They should be of interest to the passengers on Atlantic liners as well as to the navigating officers.

It may be added that the pamphlet will be of service to amateurs ashore who wish to utilise the wireless reports.

Advisory Committee on Atmospheric Pollution. Report on Observations in the Year ending March 31st, 1921. 4to., 32 pp. Plates and Diagrams. 1922. 2*s.* net.

THE seventh report of the Committee for the investigation of atmospheric pollution contains interesting accounts of experimental work as well as the usual summaries of observations.

Dr. J. R. Ashworth has contributed a paper on a twin atmospheric pollution gauge designed to compare the amount of impurity carried into a town with the amount carried out; while Dr. J. S. Owens has investigated dirt in expired air, the effect of suspended impurity on health, and the relation of visibility to suspended impurity.

Discussions at the Meteorological Office.

March 20th, 1922. *The Mean Condition of the Atmosphere during the South-Föhn.* By Luise Lammert. (Leipzig: Geophs. Inst. der Univ. Veroff., 1920, Bd. 2, Heft. 7.) Opener—Mr. R. Corless.

MOST previous investigations of the south-Föhn, the warm and unusually gusty southerly wind which is experienced chiefly in winter on the northern side of the Alpine mass, have been concerned with the consideration of surface conditions. The authoress of the present paper has made a definite attempt to throw light on upper air conditions during the Föhn. To this end she grouped together the pressures and temperatures for certain days in the period 1906–12 for which the international soundings of the upper air were available and which were also

days of Föhn, whilst information concerning air motion was derived from certain days in 1913–14, during which period numerous pilot balloon ascents were made by the Italian Aerological Service. It will be noticed that this selection of different data from different periods and the investigation of mean conditions is justified only if the general conditions during the Föhn are always the same or nearly so. From the data thus selected charts were constructed showing the distributions of temperature, pressure and stream-lines at various levels over an area comprising northern Italy, France and Germany.

It is found that the distribution of temperature at the surface, viz., an area of warm air extending from the northern side of the Alps into Germany and a cold area south of the Alps, becomes reversed as the stratosphere is approached. The mean surface pressure distribution shows a large depression to the north-west of Europe and, south of the Alps, an intrusion of high pressure from the east. With increase of height the distribution becomes more regular and at about 10 km. the gradient is for north-westerly winds over practically the whole of the area considered. There appears to be little difference in mean temperatures at all heights between the windward and leeward sides. The mean temperature in the first kilometre or so at Munich is few degrees higher than that at Pavia, but this relationship is reversed at the level of the stratosphere. There is evidence that the Föhn effect is most marked at 600–900 metres above the surface and that the Föhn often fails to break through to the surface. Immediately to the windward of the main axis of the Alps the surface air movement appears to be from the north, but at a height of 2 km. the air either travels round the mountains or crosses them by way of the passes. A vortex with a horizontal axis is definitely located near to the windward side and it is found that upward motion of the air is still well marked at 5 km. just to the windward of the mountain axis.

The average temperature lapse rate is less than adiabatic and the average upward velocity of the air to the windward is about 0·1 metres per second.

From the state of affairs revealed by this investigation it seems that the process in operation during the Föhn may be likened to that of driving a steam engine backwards, the requisite energy supply being derived from that associated with the depression to the north-west of Europe.

In the subsequent discussion it was the general opinion that the authoress was not justified in dealing exclusively with the mean conditions, and it was pointed out that no mention was made of condensation or precipitation on the windward slope

of the mountains. Sir Napier Shaw stated that soon after the onset of the southerly current a certain amount of air is forced over the mountains, but that there is soon no further tendency for this to occur and that the prolonged Föhn effect can only be explained by the existence of very effective eddy-motion and that the most developed eddy should be on the leeward side Dr. Simpson favoured the basic conception that by reason of the presence of the depression to the north-west of Europe surface air is drawn away from the leeward side and that air must necessarily descend to take its place. Other points raised were the apparent infrequency of occurrence of Föhn winds and the fact that the descending air is not necessarily that which has somewhat earlier ascended the windward side of the mountains.

The Royal Meteorological Society.

THE March meeting of the Royal Meteorological Society was held on Wednesday, March 15th, at 49, Cromwell Road, South Kensington; Dr. C. Chree, F.R.S., President, in the chair.

Before the ordinary business of the meeting, the President announced that the Council had accepted a proposal put forward by the Trustees of the British Rainfall Organization for the transfer to the Society of the lease of the old headquarters of the Organization at 62, Camden Square, together with the balance of the Endowment Fund. The conditions attached to the gift were that the Society should, as far as possible, undertake the maintenance of the meteorological observations at Camden Square and should devote the funds to the encouragement of rainfall work.

Dr. H. R. Mill, in formally handing over the property to the Society, gave a brief account of the circumstances. He spoke of the ideals which he, as successor of the late Mr. G. J. Symons, had cherished with regard to the rainfall work. The plans which were made in 1910, when the Organization was handed over to a body of Trustees, were not entirely realized owing to the breakdown of his own health and to the outbreak of war. Through the war years the work was kept going, although with great difficulty; but the stringency of 1918 made it plain that either the income must be trebled or the work allowed to pass out of private hands. When in the following year the Organization was taken over by the Meteorological Office, the Trustees retained the Endowment Fund and the house in Camden Square, the latter being leased to the Office of Works. It had now been decided to remove the Headquarters to South Kensington.

The Trustees regarded the time as opportune for handing over the house to the Society, asking them to accept the responsibility for the maintenance of the meteorological observations, one of the most accurate and homogeneous series kept in this country.

With regard to the possibility of securing the freehold of the house, and with regard to the employment of the endowment fund, the Trustees wished to leave the Society a large freedom of action. The fund was created in order to encourage the measurement of rainfall by voluntary workers, looking to the geographical rather than purely physical aspects. He earnestly hoped that the motive animating the Society in this matter would be the kindling and fostering of a spirit of enthusiasm in observation and research.

The meeting, as is customary in March, was devoted to a lecture, the lecturer this year being Dr. E. M. Wedderburn. A brief abstract follows :—

Dr. E. M. Wedderburn, O.B.E., F.R.S.E.—Seiches; and the effect of Wind and Atmospheric Pressure on Inland Lakes.

The name "Seiche" given to quasi-tidal movements of the level of inland lakes, originated in Switzerland. The scientific study of these movements began about the year 1730 on Lake Geneva, but their character as standing oscillations of the water in the lake was not recognised until Forel began his classical series of observations on that lake in 1869. At a much earlier date it had been realised that there was an intimate connection between these movements and atmospheric pressure, though some observers suggested as causes the emission of gases, or the existence of large abysmal monsters. In 1905 the late Professor Chrystal made a careful study of the seiches in Loch Earn for the Scottish Lake Survey. Simultaneous observations with a Dines-Shaw micro-barograph enabled him to discuss the effect of small barometric disturbances with much greater exactitude than had previously been possible, and he was able to show that microbaric disturbances were the most frequent cause of seiches. Other possible causes appear to be heavy rainfall over part of the lake, rapid flooding, and wind squalls. Earth tremors appear to have caused considerable movements on a few exceptional occasions. The Scottish Lake Survey also discovered the existence of internal seiches of large amplitude. During autumn, in all lakes of considerable depth, there is at the surface a layer in which there is little variation of temperature with depth. At the base of this layer there is a shallow layer, called the discontinuity layer, in which the fall of temperature is rapid, while below this is the bottom water of the lake, in which temperature variations are small.

The effect of wind blowing along a lake is to accumulate the warm surface-water at the lee end, so that the discontinuity layer is displaced from its normal horizontal position. When the wind ceases or moderates, a standing oscillation commences at the discontinuity layer, which separates the top and bottom layers. The period of oscillation depends on the difference of density between these layers. The oscillation may be of large amplitude, many feet, without measurable disturbance of the level of the free surface.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

Exceptional Visibility at Malta.

I WISH to bring to your notice a curious case of visibility noticed to-day at this Station.

At 8 o'clock (local time), the sky was overcast and covered by a layer of cumulo-stratus which kept out the rays of the sun. Towards the northern horizon, the hills of Sicily could be clearly seen by the unaided eye, although the distance is about 60 miles. When I used my 2½-inch telescope, I could clearly distinguish the trees and most of the buildings. Evidently the sky was clear over Sicily, as I could notice the eastern sides of the buildings illuminated and relatively sharp against the darker background. The phenomenon decreased in proportion as the sun came out locally, and the glare stopped the whole thing at 9 o'clock.

On November 18th, 1904, I had occasion to notice the same phenomenon, and I can give a sketch of a distant church and steeple which I noticed on that occasion, and which I believe that I have been able to identify to-day.

D. THOS. AGIUS.

R.A.F. Meteorological Station, Malta, March 15th, 1922.

[This account recalls the curious appearance observed at Malta on March 20th, 1784. At one o'clock on that day, great excitement prevailed in the streets, for a new island had apparently sprung up, and sailors and fishermen hurried out to take possession of it. It turned out, however, to be the top of Mount Etna, and later the hills and buildings of Sicily became visible.

This example, first described by Dangos in *Observations sur les refractions terrestres: Mém. Savan. Étrang.*, 1806, I., pp. 463–468, is quoted in Pernter and Exner's *Meteorologische Optik*, p. 77. The appearance of the mountain top as an island indicates that no rays from such lower parts of the land as were normally in sight could reach the observer's eyes, and that the horizon was brought much closer than usual.—ED. M.M.]

Detonating Fireballs observed in Sunshine.

A BRILLIANT fireball was observed from Bristol, Cardiff, and other places on February 7th at 3.55 p.m. The sounds resulting from its disruption were very loud, and were reported from many stations in Warwickshire, Herefordshire, Worcestershire, Oxfordshire, Gloucestershire, and even Somersetshire. They occasioned startling vibrations, and people did not know whether to attribute them to thunder or to a great explosion.

In some cases there is no doubt that meteoric detonations of this character have been erroneously attributed to thunder peals, earthquake shocks, or distant explosions.

The fireball of February 7th passed from nearly over Oxford to Shropshire, its height declining along a flight of about 80 miles from 56 to 32 miles, which it traversed at a velocity of 10 miles per second. Its radiant point was in the constellation Eridanus, near the bright star Gamma. The object was at its brightest when about half of its path had been completed, for over the district about 25 miles south of Birmingham; jets of fire and sparks were thrown off from the nucleus and the detonations were of great violence. As a sample of the descriptions which have come to hand, the following by Mr. A. W. Keep, of Quinton (see *Birmingham Daily Post*, February 13th), may be quoted :—

> " On Tuesday afternoon, about 4 p.m., a loud explosion, which is described by my wife as having literally shaken the ground, startled a number of people at Quinton, causing cattle and horses to gallop about the fields and frightening my dog so much that he ran for his life! No local cause for the noise was forthcoming."

I saw the fireball myself at Bristol, and heard a deep sound as of a distant thunder-clap about 4½ minutes later.

These large daylight meteors are not so rare as might be imagined—twelve have been witnessed in the British Isles since the beginning of 1902. They deserve special investigation in view of the fact that they are often attributed to other causes, and especially so when clouds veil their luminous flights, and the only manifestations are the loud sounds and earth tremors which they produce.

Certain epochs of the year appear to be unusually prolific in detonating fireballs, as, for example, that of November 19th–23rd.

W. F. DENNING.

Bristol, February 21st, 1922.

Definition of Frost in the Open.

On January 4th last, when there was a strong, dry, north-west wind, nearly an inch of ice was formed here with a minimum temperature in the screen as high as 31° F. This is a case where low humidity and movement of the air played a greater part in the formation of ice than low temperature. In order to define the strength of a frost, it would appear to be necessary to take into account all three factors as well as the effects of radiation but, unfortunately, the readings of the wet-bulb thermometer are not very reliable when the temperature of the air is below freezing point. However, it is a simple matter to record the temperature on the grass and I submit that when "degrees of frost" are spoken of, the reference should be to the indications of the thermometer exposed to the full effects of radiation. The term "ground-frost" would not appear to be necessary, since if it is freezing on the grass, frost is apparent everywhere in the open, and ice may be formed on water several feet above the ground. Thus at 7 h. on February 19th last there was a thin sheet of ice on the rainwater tank in my garden. The tank is 7 feet above the ground and the indications of the minimum thermometers 60 feet away were 33°.1 F. in screen and 29°.5 F. on grass.

I have noticed, when skating, that the ice keeps dry and in good condition so long as the thermometer on the ground is down to 32° F., even if the sun be quite strong and the temperature of the air be as high as 40°. If, however, it becomes cloudy and the temperature of the air falls to, say, 35° F., whilst the thermometer on the ground rises to the same level, a thaw at once sets in.

The views of other observers on this matter would be interesting and helpful to me.

DAVID HILL OWEN.

192, *Redding Lane, Sparkhill, Birmingham, 8th March* 1922.

[The point which Mr. Owen emphasizes, that the reading of the "grass minimum thermometer" is essentially the temperature of a radiating body is in accordance with *The Observer's Handbook*. In recent editions of the Handbook the following paragraphs have appeared:—

> "*Terrestrial Radiation Thermometer.*—A grass-minimum thermometer does not record the temperature of the air, but rather its own temperature, *i.e.*, that of a bulb filled with spirit, losing heat by radiation in all directions, and receiving heat by radiation from the clouds and from the atmosphere itself, from the ground, and from surrounding objects, and by contact with the air."

"Although the grass-minimum thermometer does not give the temperature of the air or of the grass-blades, its readings do indicate the circumstances in which those temperatures are high or low. It is customary in this country to count as ground-frosts the occasions on which the temperature recorded by the grass-minimum thermometer is 30° F. or lower."

Observations with thermometers exposed at various heights are necessary to settle the question how far Mr. Owen's suggestion to drop the term "ground-frost" is acceptable.—ED. M.M.]

A Curious Ice Formation.

ON the morning of Sunday, February 5th, I noticed an unusual formation of ice on the ground in the form of "ice pinnacles" or upward pointing icicles They were to be found only on bare ground and invariably had small pieces of chalk or in some cases small pieces of broken brick or ashes as a base; in no instance on flints or on the soil itself. They were generally about two inches in height, mostly quite straight, but sometimes curved. Externally they had an appearance of striation; they were hollow, partly filled with feathery snow-like crystals.

In low-lying fields they were extremely numerous and were observed over a large district including Welwyn, Hitchin and Luton. The air was very cold the preceding evening, with a light snow which melted as it reached the ground which overnight showed no signs of ground frost, but was frozen on the morning of the 5th. During the night the velocity of the wind was from 3 to 12 miles per hour, minimum grass temperature 26° F., minimum screen temperature 27° F. On the 4th at 9 h. the temperature one foot below the surface was 42° F. and on the 5th, 38° F. No hoar frost was recorded.

ALFRED LATCHMORE.

Hitchin, February 13th, 1922.

[The formation of "ice pinnacles" as described by Mr. Latchmore is a fairly common phenomenon in chalky districts, being caused by the exudation of moisture from porous soil. We do not know whether the details of the process have been investigated. Cleveland Abbe has invoked surface tension to explain* a somewhat similar phenomenon, the growth of the ice pinnacles which push up soil or gravel, but we have not found it possible to adapt his explanation to the present case.—ED. M.M.]

* *Monthly Weather Review, Washington*, April 1905, p. 157. See also, *ibid.*, December 1905, p. 527, and July 1916, p. 386.

The Drought of 1922.

IT may help to impress the seriousness of last year's drought on our minds to mention that from October 1st, 1920, to December 31st, 1921 (15 months), the rainfall of every month was below its average at this station. In previous years from and including 1900, when my record begins, there were never less than three months above the average in the year.

ALFRED WALKER.

Ulcombe Place, Nr. Maidstone, 13th March, 1922.

Weather Lore.

SIR NAPIER SHAW mentions the local belief in the windiness of Edinburgh, and asks why it should be so. In *Tristram Shandy*, Sterne mentions a similar belief about Avignon and asks the same question. The passage contains some shrewd remarks about the folly of drawing general conclusions from isolated instances and is worth quoting :—

> " Before I go further, let me get rid of my remark upon Avignon, which is this: That I think it wrong, merely because a man's hat has been blown off his head by chance the first night he comes to Avignon, that he should therefore say, 'Avignon is more subject to high winds than any town in all France': for which reason I laid no stress upon the accident till I had enquired of the master of the inn about it, who telling me seriously it was so—and hearing, moreover, the windiness of Avignon spoke of in the country about as a proverb—I set it down, merely to ask the learned what can be the cause."—(" Everyman's " edition, p. 390.)

E. G. BILHAM.

The Oaks, Cambridge Road, Twickenham, March 23rd, 1922.

Meteorological Terms.

THE Meteorological Office is, I see, raising the question of the meaning of " fine to fair " to the man in the street. May I deprecate the use of the word " local." The man in the street thinks of his local paper, and, if a " local shower " does not fall in the spot where he happens to be, he curses the Meteorological Office. I suggest " in places " instead of " local."

H. NOWELL FFARINGTON.

Worden, Leyland, Lancs, Feb. 3rd, 1922.

NOTES AND QUERIES.

Coal Smoke Abatement.

A DEPUTATION, organized by the Coal Smoke Abatement Society, was received at the Ministry of Health on March 20th, 1922, by Sir Alfred Mond. The object of the deputation was to urge the Government to give legislative effect to the recommendations made by the Departmental Committee under the chairmanship of Lord Newton. Representatives from various boroughs as well as from learned, scientific and health institutions were present. Sir Napier Shaw and Mr. F. J. W. Whipple represented the Royal Meteorological Society.

Sir Aston Webb, in his speech, laid stress on the great damage by smoke to works of art and to property, as well as to health and pointed out the great waste of fuel, amounting to a loss of many millions in a year.

The Lord Provost of Glasgow described the work done in that city, and Mr. Smith, in the unavoidable absence of Mr. Clynes, discussed the problem from the point of view of the working-classes.

Sir Napier Shaw referred to the work of the Committee on Atmospheric Pollution and pointed out that two-thirds of the smoke was from domestic fires and suggested that a special abatement in rates should be conceded to houses producing no smoke.

Sir Alfred Mond said that before the report was adopted he should have to discuss it in detail with Lord Newton. He mentioned that the recommendation in the Report that the Ministry should appoint competent advisers to help local authorities and manufacturers had already been carried out.

The Economic Value of Dry Air.

A PAPER by J. Bronn on means of providing dry air cheaply, which was published in *Stahl und Eisen* for June 16th, 1921, has directed the attention of ironmasters in this country to the economy of utilising dry air instead of moist air for feeding blast furnaces. Experiments conducted at the great ironworks at Rombach showed that the air near ground level generally contained 20 per cent more moisture than that at a height of 100 ft. When the works are in full swing great clouds are given off from the water sprayed on the hot iron for cooling it, and if no precautions are taken this water vapour is pumped into the furnaces with the air. Not only is it wasteful to spend the energy of the pumps on this unnecessary work, but the complete combustion of the coke in the furnaces is delayed, heat being generated in the chimney instead of under the melting ore.

It has been found profitable at Rombach to connect the suction for all the blowing engines to a tower 150 ft. high and so obtain a supply of dry air. It is reckoned that the saving in coke by this change of practice may amount to 3 per cent. On the other hand, there are no heavy running expenses such as are incurred with the more thorough-going Gayley process, in which the air is deprived of all it moisture by passage through a chamber where it is cooled to the freezing point.

There must be many other industries which might profit by the experience of the ironworks. The atmosphere surrounding electric power-stations is frequently filled with steam from the cooling towers, and some of this steam must find its way to the furnaces of neighbouring works. Laundries again must suffer by the introduction of moist air into the drying rooms and for them also the installation of towers from which dry air could be drawn would probably prove economical.

International Investigation of the Upper Air.

As announced on page 20 of the *Meteorological Magazine* for February, 1922, January 17th, 18th and 19th were set apart as international days for the investigation of the upper air. It happened that on these days the last phase, or the "death," of a cyclone was taking place

Some account of the observations made in the British Isles may be of interest. Observations were made as nearly as possible at 7h. and 18 h. at twenty-three stations. Nephoscope observations were obtained from fifteen stations, cirrus being reported from thirteen. Upper winds were observed from eighteen stations by means of pilot balloons. In the majority of cases a single theodolite was used, but at Larkhill and Shoeburyness two theodolites were utilised on some occasions. At Shoeburyness, also, the wind at 18,000 feet was obtained by means of a shell-burst. The greatest height reached by a pilot balloon was 20,000 feet, ascents of this height being recorded both from Felixstowe and from Valencia. The majority of balloons did not reach great heights owing to the presence of low cloud. Seven stations recorded upper air temperatures, the results being obtained by aeroplane ascents at Andover, South Farnborough, Baldonnell, and the Isle of Grain, by registering balloons at Benson, by kite-ballon and meteorograph at Shoeburyness, and by kite and meteorograph at Pulham. The upper winds were moderate to strong and had a marked westerly component. The lowest temperature recorded in the aeroplane observations was 235a ($-36°$ F.) at 18,000 feet at South Farnborough.

The Conquest of the Air.

A NEW record for flight duration has been officially recognised by the Fédération Aéronautique Internationale, which publishes world records from time to time in its Bulletin. This record

flight was made in America on December 29th and 30th, 1921, by F. Stinson and L. Bertand, the duration being 26h. 19m. 35s. The previous record, which was a French one, was 24h. 19m. 7s.

A speed equivalent to 206 miles per hour was obtained over a distance of 1 kilometre by Sadi Lecointe at Villesauvage on September 16th, 1921, and speeds of over 170 miles per hour have been recorded for flights over longer distances.

Major R. W. Schroeder's ascent* of 36,000 feet at Dayton, Ohio, on February 27th, 1921, is still the record for altitude, but a report† which will, it is hoped, be authenticated later, has been received of a still higher ascent—of over 40,000 ft.—also at Dayton.

News is also received of a daring flight by Major Cotton, a British airman, carried out under very unfavourable conditions.

Major Cotton set out from St. John's, Newfoundland, with mail for the lonely settlement at Cartwright, Battle Harbour, on the Labrador coast. Flying was rendered very difficult by great masses of cloud, but St. Anthony, 200 miles away, was reached in 2½ hours. After leaving St. Anthony, Major Cotton encountered a severe snowstorm, but he reached Battle Harbour and, despite a strong east wind, landed safely. One of his skids was damaged, however, but after this had been repaired, Cartwright, 100 miles away, was reached. Major Cotton landed in the midst of a group of rather scared Eskimos who had never before seen an aeroplane. The settlers at Cartwright were surprised to receive letters from Newfoundland which had been written only the day before, for from January to June the coast is closed and they are cut off from the world. The return journey to St. John's was accomplished in five hours.

This flight is not only a fine feat of endurance, but also a record, for flight under such conditions has hitherto been considered impossible.

Wireless for Tristan da Cunha.

It is reported in the Press that the Rev. H. M. Rogers, who sailed last month for the lonely island of Tristan da Cunha to take up the chaplaincy, has taken with him " wireless " apparatus with a range of over 1,000 miles. The apparatus was presented to Mr. Rogers by the people of Cape Town to whom the loneliness of the island has always appealed.

Mr. Rogers is also taking with him meteorological equipment furnished by the Government so that he may send reports of the weather conditions by wireless telegraphy to South Africa and to passing ships. The message should be of considerable assistance to forecasting in South Africa.

Some account of meteorological work at Tristan da Cunha is given in this Magazine for April, 1920, p. 49.

* *Meteorological Magazine*, March 1920, p. 25.
† *Ibid.*, October 1921, p. 269.

A Test of "Simple Weather Forecasting."

READERS of *Simple Weather Forecasting*,* the pamphlet in which Messrs. Horner and Robertson have set out the principles on which their published forecasts are prepared, find it difficult to select clear-cut statements which can be submitted to the test of experience. There is one rule, however, on the face of it definite enough to claim rank as a proverb "When the cold snap in the spring occurs early, the summer will be early."

It has been thought worth while to examine the weather records for south-east England for 21 years with this dictum in mind.

As to what periods the expression "a cold snap in the early spring" and an "early summer" may refer, no two people may agree, but for the purpose of this enquiry a cold snap in the spring was said to occur early when it occurred in February or March, and the summer was regarded as early when summer conditions prevailed during May or June.

Of the 21 years from 1901 to 1921 there were nine in which the "cold snap" occurred in spring. In four of these years, 1901, 1905, 1917 and 1919, the "early summer" followed, but in the others, 1904, 1906, 1908, 1909 and 1916 it did not.

The available evidence, therefore, shows that any relation which may exist between the weather of spring and summer is not to be summed up in such a formula as is proposed in *Simple Weather Forecasting*.

La Société Belge d'Astronomie, de Météorologie et de Physique du Globe.

THE Belgian Society for Astronomy, Meteorology and Terrestrial Physics celebrated the completion of its twenty-fifth year by a "séance solennelle" on December 15th, 1921, at which the King and Queen of the Belgians and representatives of many of the European Governments were present.

The January number of *Ciel et Terre* is devoted to an account of the proceedings, which included a lecture by Monsieur B. Baillaud on astronomy and one by General Ferrié on wireless telegraphy and telephony.

The Society is to be congratulated on its recovery after the great strain produced by the war, and its distinguished President, Monsieur F. Jacobs, on his long term of office, coincident with the life of the Society, which, in fact, owes its existence to his initiative.

---

* *Simple Weather Forecasting for Everyone*, by D. W. Horner and W. M. Robertson. Tunbridge Wells, 1921.

Radiation at Benson.

RADIATION MEASURED AT BENSON, OXON, 1922.

Unit : one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays).

Averages for Readings about time of Sunset.

		Jan.	Feb.	Mar.
Cloudless days :—				
Number of readings	n	11	14	19
Radiation from sky in zenith	I	409	420	456
Total radiation from sky	J	442	458	488
Total radiation from horizontal black surface on earth.	X	618	640	667
Net radiation from earth	X–J	176	182	179

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

Cloudless days :—				
Number of readings	n_0	3	5	3
Radiation from sky in zenith	I_0	21	25	26
Total radiation from sky	J_0	25	33	39
Cloudy days :—				
Number of readings	n_1	9	5	5
Radiation from sky in zenith	I_1	38	55	75
Total radiation from sky	J_1	34	53	64

Radiation from the Sky at Benson.

IN the January number of the Magazine there is an editorial comment* on the difference of the averages of the net radiation from the ground for 1920 and 1921. The following is the explanation :—

For 1920 no direct observations on the radiation given out by the ground were available and to supply the deficiency it was assumed that the radiation from the ground was that of a full radiator at a temperature of 50° F., which is close to the mean annual temperature at Benson at a depth of 1 foot. For 1921 the observations of radiation from the ground (a grass field) are available and have been used as a standard. It appears that

* p. 351.

the observed radiation from the gound is, for 1921 at least, some 20 g.c. less than that from a full radiator at the temperature in the screen at the time and thus two-thirds of the discrepancy is accounted for.

The remaining 10 g.c. difference may well be a casual deviation especially when the exceptional heat and dryness of the year 1921 is remembered.

The radiation from the ground seems to be a very variable quantity and subject to a large diurnal oscillation the amplitude and phase angle of which have not yet been determined.

W. H. DINES.

Cosmic Dust?

Dr. OWENS and Mr. Watson have recently detected in the atmosphere of London particles comprised of a clear, glassy material, and perfectly spherical in shape, of diameter from 1·5 microns downwards. Such particles had been observed occasionally at earlier dates, but they did not appear in large numbers until March 16th; a maximum was reached about March 26th, when there were about 500 such particles to the cubic centimetre. The subsequent decrease has been gradual.

It has been suggested that the particles may be derived from volcanic eruptions, both Etna and Vesuvius having been active recently, or that they may be cosmic dust.

Meteorological Stations.

As announced on p. 66, the meteorological station at 62, Camden Square, N.W.1, originated in 1858 by the late Mr. G. J. Symons, F.R.S., and maintained since 1919 as an official station of the Meteorological Office, has now been taken over by the Royal Meteorological Society. It is hoped that the continuation of the records, for at least the 20 years remaining of the lease of the house, has been secured, and that arrangements for permanence may be possible. The old "Glaisher" thermometer screen has been replaced by a Stevenson Screen and the observations have been slightly simplified. For the present, the observations are being undertaken by the North London Collegiate School.

Summer Time Act.

SUMMER Time came into force this year on March 26th and will continue until October 8th. Observers are reminded that it is important to state explicitly the standard of time on all communications with regard to natural phenomena observed during the summer months.

Rain-Making in Central Africa.

ACCORDING to the Rev. John Roscoe, who has just published *The Soul of Central Africa*, rain-making can be a very uncomfortable profession. Mr. Roscoe describes the work of the rain-makers in Ankole, a remote province in the heart of Africa. When rain is needed, the rain-makers are sent for and told to produce it. Should they fail, they are made to sit in the sun and are fed on liver cooked in butter with as much salt as can be got into it. When the unfortunate men beg for water, they are told to "Bring rain and quench your thirst." On the other hand, if too much rain falls, and the rain-makers fail to stop it, they are forced to drink enormous pots of water until the rain ceases.

Meteorological Terms in the Malagasy Language.

THE Malagasy names for some of the more striking weather phenomena are given in *A Naturalist in Madagascar*, by James Sibree.

Sun - -	Day's Eye - -	Mascandro.
Milky Way -	Dividing of the year	Èfitaona.
Rainbow -	God's great knife -	àntsìbèn Andriàmànitra.
Waterspout -	Tail of the sky -	Ràmbondànitra.
Cirrus Clouds -	Sky gossamer - -	Faròran-dànitra.

These terms are certainly picturesque. That of the waterspout is really very apposite. As regards the Cirrus clouds, it is interesting to see how the same forms suggest different ideas to various nations. (Latin: a lock of hair or fringe; English: Mares' tails). The Malagasy name is certainly the most poetical.

CICELY M. BOTLEY.

Weather Terms used by the Hastings Fishermen.

THE following note by Mr. W. R. Butterfield is copied by permission of the author from the *Hastings and East Sussex Naturalist*, Vol. iii, 3:—

> "The vocabulary of the Hastings fishermen includes some curious meteorological terms, and as these are rapidly being lost, it may be as well to give a list of them in this journal. When there is a dead calm, with the air hot and moist, the weather is said to be 'planety.' If it is oppressively sultry, with a heavy sky and oily sea, it is 'swallocky,' and presages a heavy storm which sometimes breaks suddenly with a roaring squall. A long loop of cirrus cloud with trailing ends is called by the curious name 'eddenbite'; blown-out streamers of white cloud are

'windogs,' as are also solar halos; large, ragged patches of nimbus cloud scurrying before a wind are 'messengers': small, scattered, low cumulus clouds floating in an otherwise clear sky are 'pot-boys.' A mock-sun or parhelion is known by the name 'smither-diddles' and regarded as a sign of bad weather. The fishermen distinguish between hard and soft hail, the latter being described as 'egger-nogger.' Changeable weather is described as 'shucky' and when there is every prospect of really 'dirty' weather the conditions are described as 'truggy.'"

Retirement of Mr. R. S. Sargeant.

THE retirement of Mr. R. S. Sargeant took place on March 31st, after a period of service in the Meteorological Office which dates from 1871. Mr. Sargeant is the last of the senior members of the Office Staff who can claim that his first appointment was made in the days when the late Dr. R. S. Scott was in charge of the Office. Throughout the greater part of his career Mr. Sargeant has been associated with the Forecast Division, and since 1901 he has been one of the officers in charge of the issue of forecasts and gale warnings. The war brought with it a great increase, both in the scope and in the responsibility of such work, and Mr. Sargeant responded to the call with unfailing devotion. We wish him good health and prosperity in his retirement.

Fog and Frost Warnings at Cranwell.

AT the Royal Air Force Station at Cranwell a Frost Warning Signal has been in use during the winter months. On occasions when a frost, likely to cause damage to water-pipes, machinery and so on, has been forecasted, a red light is exhibited between 16h. 30m. and 18h. and again between 22h. and 22h. 30m. Fog warnings are also issued at Cranwell. Both fog and frost warnings are communicated from Cranwell to the Great Northern Railway Company's junction at Sleaford, as required.

The Horse Latitudes.

ACCORDING to more than one handbook of meteorology the "horse latitudes" are so called because on various occasions vessels, whose cargoes consisted of horses, were becalmed there and owing to the heat the horses died. Can any reader supply the original authority for this statement or, failing that, a more plausible explanation of the term?

The Weather of March 1922.

THE wind circulation over north-western Europe during the first week was generally cyclonic; depressions from the neighbourhood of Iceland passed eastwards across the north of Scandinavia, while secondary disturbances traversing the British Isles occasioned variable mild weather and rather frequent gales.

On the 1st, gales and strong winds were experienced in southern England. Kew at 2h. 30m. measured a gust of 24·5 metres per second, and later on the same day a line-squall, moving eastwards over the same area, caused a drop of temperature amounting at Kew to 6° F. Gales were again recorded on the 3rd and the 5th–6th. Temperature fluctuated a good deal, but was generally above normal, while on the 3rd a marked increase took place over Holland, the maximum reading at Groningen rising 15° F. The maxima at Benson, Gorleston and Pulham rose to 59° F., and on the following night, minima were very high, 52° F. being recorded at Kew. Rainfall was heavy at times; that at Penzance on the 1st measured 30 mm., and on the 5th 26 mm. were recorded at Eskdalemuir.

The breakdown of the westerly type followed on the arrival from the Atlantic of a disturbance of exceptional intensity. At 7h. on the morning of the 7th this depression was in mid-ocean and showed no extraordinary vigour. It deepened considerably, however, during its passage, and by the time it reached Plymouth, pressure at the centre had sunk to 970 mb. Wind velocities in Southern England, and especially in the western Channel, were abnormally high. Scilly recorded a gust of 108 miles per hour, a higher velocity* having been measured only once before in the British Isles. The history of its passage is well shown by the autographic records at Plymouth. The pressure, which stood at 1,000 mb. at 22h. on the 7th, fell quickly until 24h. and then extremely rapidly to 970 mb. at 5h. 15m. on the 8th, when the trough passed across. A very brisk rise followed, the barometer reaching 1,000 mb. again by 18h. The strongest winds occurred during the fall of pressure, the climax being reached at 4h. 10m. with a gust of 96 miles per hour, but thence onwards the velocity dropped even more quickly than it had risen. Temperature after some minor fluctuations rose from 46° F. at 1h. to 51° F. at 2h. 30m., a fall then commencing and continuing; the reading at 4h. 10m., when the screen was carried away,† being 44° F.

Rainfall reached it maximum intensity (3·8 mm. per hour) between 24h. and 1h.—then, decreasing steadily, 1 mm. was measured between 4h. and 5h. and none between 5h. and 6h. A further fall commenced after 6h., 1 mm. being measured up to 7h. Considerable structural damage was caused on the line of route. At Plymouth many ships dragged their anchors, trees of 5 ft. in diameter were uprooted, while a roof 30 ft. by 15 ft. was lifted and carried a distance of about 1,000 yards.

By 13h. on the 8th, the cyclone was centred off East Anglia, having moved eastwards, with a velocity averaging over 40 miles per hour.

In the rear of this extraordinary depression a northerly to north-easterly drift set in as an anticyclone advanced from the Atlantic, and by the 13th became established over our northern districts. It extended in a ridge eastwards and drier but colder weather became general except

---

* This gust, at Quilty, Co. Clare, January 27th 1920, which carried the pen beyond the edge of the chart, reached 110 miles per hour.

† See *Meteorological Magazine*, March 1922, p. 52.

in the south-west. Meanwhile a depression in the region of the Bay of Biscay caused local precipitation (12 mm. at Paignton and 10 mm. at Plymouth being the largest), but only small falls occurred.

Temperature fell considerably, severe frost being experienced during the night on several occasions. A minimum of 3° F. occurred at Särna on the 9th, and on the night of the 10th–11th 15° F. was recorded on the grass at South Farnborough, the screen reading at the same time falling to 21° F. Frost was experienced at Eskdalemuir on successive days, temperature falling to 21° F. on the grass and to 26° F. in the screen on the 18th. Milder conditions, however, had obtained in Scotland at times, and on the 12th Renfrew recorded a maximum of 57° F.; but on the whole during these days 50° F. was passed at but few places, while on the 18th the thermometer at Harrogate rose only to 39° F. During the same period southern Europe and the extreme north were influenced by depressions. On the 8th, Bayonne measured 81 mm. of rain; on the 15th 30 mm. fell at Sanguinaire, and on the 18th 21 mm. at Bronnö. Low temperatures were experienced at Spitzbergen, and 20° F. was recorded on the 17th.

By the 20th, weather conditions over the British Isles had become much more unsettled, with cold northerly winds. Hail, snow and sleet, first experienced in Scotland on 20th, had by 21st travelled quickly south, falls of snow being recorded even in the Scilly Isles. The falls in the north were, however, much heavier than elsewhere, and with the wind half a gale at times, drifts many feet in depth were formed. An ascent on the 20th at Leuchars showed temperatures in the upper air to be much below normal, amounting to 15° F. at a pressure of 650 mb. On the night of the 20th–21st the whole country was gripped by frost; Benson then measured 14° F. of ground frost, and Plymouth 10° F. Severe frost was again experienced in the eastern and south-eastern district on the 24th. Screen minima fell to 20° F. at Grain and Shoeburyness, while at the latter station 20° F. of frost were recorded on the ground. On the following days maximum temperatures were also low; at Lympne and Tunbridge Wells 34° F. was the highest reading on the 22nd, and day temperatures in Northern Europe were generally below 40° F., the maximum at Bornholm on the 22nd being 28°.

A temporary change in type occurred on the 24th and 25th, when a depression moved in from the Atlantic across France, 60 mm. of rain being measured at Toulouse, but a return to northerly winds followed and frequent hail or sleet showers were recorded generally on the 29th. With the development of a depression off the south-west coasts, and a rise of pressure in the north, an easterly current became general. Maxima on the 31st fell to 40° F. or below except in the south-west, and severe frost was experienced over a wide area on the previous night. Sunshine was very variable in quantity during the month, but records of over 10 hours were obtained on the 12th, 21st, 22nd and 23rd.

S. F. WITCOMBE.

There was much general bad weather in Northern and Central France, with gales, during the early part of the month, and cold winds and snow in the latter period. The Mi-carême fêtes in Paris were quite spoilt. Temperature was also below normal on the Riviera; on the 26th the maximum reading was only 3° F. above that of London.

In the first week of the month during a heavy snowstorm in the Dauphiné Alps, in the department of Hautes Alpes, a number of living spiders, ants, caterpillars and other insects, unknown

to the region, fell with the snow and were subsequently buried by another fall.

According to a report received from the Dobruja on the 17th, the Danube has overflowed its banks and several villages have been submerged.

It is stated in *The Times* on March 28th that unusually heavy rains have filled all but one of the historic reservoirs of Aden.

On the 31st another great cold storm, resembling that of February, paralysed the hydro-electric services throughout Western Ontario.

Fifteen persons were killed and many injured by a tornado in the State of Oklahoma, U.S., near the middle of the month. Strong floods were crumbling the banks on the Mississippi River in the neighbourhood of Helena, Arkansas, at the end of the month. A section of the Missouri-Pacific Railway was under water and the situation was becoming critical. There was a very extensive depression covering the whole of the Mississippi and Missouri Valleys on the 19th, with extensive rainfall, but later synoptic charts are not to hand.

During a severe thunderstorm on the 22nd a naval ammunition dump at Rio de Janeiro was struck by lightning and destroyed.

The special message from Brazil states that rain was irregular in the north but very excessive in the centre and south, being more than 100 mm. above normal in almost all parts, while many stations had an excess of 200 or even 300 mm. The heaviest falls came at the end of the month; there were destructive floods in the States of Rio de Janeiro and São Paulo. Thus while in the north-east the cotton crop is suffering from lack of rain, the rice crop in the south is being damaged by abnormally heavy precipitation.

At Rio de Janeiro pressure was 1·2 mb. below the normal for the month, and temperature was 1·1° F. above the normal.

On March 5th news was received of a disastrous cyclone which destroyed Chinde, the port at the mouth of the Zambesi, in Portuguese East Africa, on February 24th. It is stated to be the most disastrous event of its kind that has occurred on the East African Coast. The storm approached from the north-west down the river valley and lasted for 16 hours ending at midnight. There was a calm period of an hour about 17h. with a complete change of wind direction from westerly to easterly. The town, which was not very substantially built, was completely destroyed, and all the vessels, in the harbour save two, were thrown on shore, in several cases piled one on the top of another. The loss of life was, however, not very great. This cyclone appears to have been one from the south Indian Ocean which came unusually far west and recurved over the African Coast. During the

(*Continued on* p. 88.)

Rainfall Table for March 1922.

STATION.	COUNTY.	Aver. 1881–1915.	1922.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days
		in.	in.	mm.		in.	Date.	
Camden Square	*London*	1·83	1·51	38	83	·26	7	17
Tenterden (View Tower)	*Kent*	2·14	2·33	59	109	·73	7	19
Arundel (Patching Farm)	*Sussex*	2·15	1·95	49	91	·64	7	15
Fordingbridge (Oaklands)	*Hampshire*	2·33	2·53	64	109	·52	31	16
Oxford (Magdalen College)	*Oxfordshire*	1·53	1·70	43	111	·32	7	15
Wellingborough (Swanspool)	*Northampton*	1·79	1·62	41	91	·31	7	16
Hawkedon Rectory	*Suffolk*	1·90	2·21	56	116	·28	1	17
Norwich (Eaton)	*Norfolk*	1·91	2·25	57	118	·45	29	19
Launceston (Polapit Tamar)	*Devon*	2·98	4·42	112	148	·63	7	19
Sidmouth (Sidmount)	"	2·44	3·12	79	128	1·28	31	17
Ross (County Observatory)	*Herefordshire*	2·03	2·91	74	143	·55	31	16
Church Stretton (Wolstaston)	*Shropshire*	2·36	3·17	81	134	·65	1	15
Boston (Black Sluice)	*Lincoln*	1·56	1·61	41	103	·29	7	20
Worksop (Hodsock Priory)	*Nottingham*	1·69	1·35	34	80	·24	7	21
Mickleover (Clyd House)	*Derbyshire*	1·78	1·96	50	110	·51	8	17
Southport (Hesketh Park)	*Lancashire*	2·23	1·34	34	60	·41	4	14
Harrogate (Harlow Moor Ob.)	*York, W. R.*	2·26	2·08	53	92	·29	5	19
Hull (Pearson Park)	" *E. R.*	1·82	1·80	46	99	·35	1	22
Newcastle (Town Moor)	*North'land.*	2·11	1·73	44	82	·30	25	19
Borrowdale (Seathwaite)	*Cumberland.*	11·15	7·00	178	63	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan.*	3·21	..	..	..	..	..	..
Haverfordwest (Gram. Sch.)	*Pembroke*	3·41	3·68	93	108	·75	7	17
Aberystwyth (Gogerddan)	*Cardigan*	3·47	3·39	86	98	·95	5	10
Llandudno	*Carnarvon*	2·17	1·81	46	83	·37	30	12
Dumfries (Cargen)	*Kirkcudbrt.*	3·61	3·15	80	87	·88	4	15
Marchmont House	*Berwick*	2·65	2·19	56	83	·29	20	21
Girvan (Pinmore)	*Ayr*	3·77	1·95	49	52	·42	4	14
Glasgow (Queen's Park)	*Renfrew*	2·61	1·67	42	64	·71	4	12
Islay (Eallabus)	*Argyll*	3·82	2·25	57	59	·47	4	16
Mull (Quinish)	"	4·43	3·02	77	68	·82	4	16
Loch Dhu	*Perth*	6·59	3·40	86	52	1·10	4	11
Dundee (Eastern Necropolis)	*Forfar*	2·06	1·72	44	83	·43	6	15
Braemar (Bank)	*Aberdeen*	2·98	2·03	52	68	·26	4	19
Aberdeen (Cranford)	"	2·58	2·47	63	96	·35	25,26	17
Gordon Castle	*Moray*	2·32	2·00	51	86	·39	26	18
Fort William (Atholl Bank)	*Inverness*	6·84	4·40	112	64	1·24	5	16
Alness (Ardross Castle)	*Ross*	3·26	2·89	73	89	·42	27	21
Loch Torridon (Bendamph)	"	7·50	6·54	166	87	·93	7	20
Stornoway	"	4·10	2·75	70	67	·46	4	22
Loch More (Achfary)	*Sutherland*	6·44	7·05	179	111	1·31	11	22
Wick	*Caithness*	2·27	1·67	43	74	·26	24	20
Glanmire (Lota Lodge)	*Cork*	3·10	2·33	59	75	·69	4	16
Killarney (District Asylum)	*Kerry*	4·71	4·54	115	96	1·40	4	16
Waterford (Brook Lodge)	*Waterford*	2·75	1·31	33	48	·35	4	15
Nenagh (Castle Lough)	*Tipperary*	3·09	2·07	53	67	·80	4	16
Ennistymon House	*Clare*	3·40	2·46	63	82	·64	4	15
Gorey (Courtown House)	*Wexford*	2·31	2·09	53	90	·30	4	17
Abbey Leix (Blandsfort)	*Queen's Co.*	2·62	1·49	38	57	·37	4	13
Dublin (FitzWilliam Square)	*Dublin*	1·94	1·05	27	54	·21	4	14
Mullingar (Belvedere)	*Westmeath*	2·70	1·97	50	73	·50	4	15
Crossmolina (Enniscoe)	*Mayo*	4·52	3·49	89	77	·41	4	18
Collooney (Markree Obsy.)	*Sligo*	3·46	2·93	74	95	·51	8	17
Seaforde	*Down*	2·92	1·94	49	66	·48	30	11
Ballymena (Harryville)	*Antrim*	3·15	2·27	58	72	·29	4	18
Omagh (Edenfel)	*Tyrone*	3·14	2·35	60	75	·30	8	16
Letterkenny Asylum	*Donegal*	3·80	2·25	57	59	·44	4	17

Supplementary Rainfall, March 1922.

Div.	STATION.	RAIN.		Div.	STATION.	RAIN.	
		in.	mm.			in.	mm.
II.	Ramsgate	..	..	XII.	Langholm, Drove Rd.	3·19	81
,,	Sevenoaks, Speldhurst	2·30	58	XIII.	Ettrick Manse	4·33	110
,,	Hailsham Vicarage	2·32	59	,,	North Berwick Res.	1·58	40
,,	Totland Bay, Aston Ho.	2·86	73	,,	Edinburgh, Royal Ob.	1·59	41
,,	Ashley, Old Manor Ho.	2·56	65	XIV.	Biggar	1·71	43
,,	Grayshott	3·34	85	,,	Leadhills	4·06	103
,,	Ufton Nervet	2·24	57	,,	Kilmarnock, Agric.Coll.	2·00	51
III.	Harrow Weald, Hill Ho.	1·69	43	XV.	Dougarie Lodge	2·03	52
,,	Pitsford, Sedgebrook	1·48	38	,,	Oban	2·45	62
,,	Chatteris, The Priory	1·67	42	,,	Holy Loch, Ardnadam	..	..
IV.	Elsenham, Gaunts End	2·40	61	,,	Tiree Cornaigmore	..	..
,,	Lexden, Hill House	1·55	39	XVI.	Loch Venachar	3·80	97
,,	Aylsham, Rippon Hall	1·98	50	,,	Glenquey Reservoir	4·30	109
,,	Swaffham	2·04	52	,,	Loch Rannoch, Dall	2·00	51
V.	Devizes, Highclere	2·39	61	,,	Blair Atholl	1·73	44
	Weymouth	2·44	62	,,	Coupar Angus	1·73	44
,,	Ashburton, Druid Ho.	6·25	159	,,	Montrose Asylum	1·91	49
,,	Cullompton	2·96	75	XVII.	Logie Coldstone, School	2·72	69
,,	Hartland Abbey	3·31	84	,,	Fyvie Castle	2·22	56
,,	Penzance, Morrab Gden.	4·00	102	,,	Grantown-on-Spey	3·06	78
,,	St. Austell, Trevarna	3·67	93	XVIII.	Kingussie, Fasnakyle	..	..
,,	Crewkerne Merefield Ho	3·66	93	,,	Fort Augustus	..	..
VI.	Clifton College	3·59	91	,,	Loch Quoich, Loan	7·60	193
,,	Ledbury, Underdown	2·63	67	,,	Fortrose	1·36	35
,,	Shifnal, Hatton Grange	2·63	67	,,	Faire-na-Squir	..	..
,,	Ashbourne, Mayfield	2·39	61	,,	Skye, Dunvegan	2·91	74
,,	Barnt Green, Upwood	2·08	53	XIX.	Loch Carron, Plockton	2·55	65
,,	Blockley, Upton Wold	2·37	60	,,	Dornoch, St. Gilbert's	1·75	44
VII.	Leicester, Town Hall Sq.	1·81	46	,,	Tongue Manse	2·86	73
,,	Grantham, Saltersford	1·82	46	XX.	Melvich Schoolhouse	3·07	78
,,	Louth, Westgate	2·38	61	,,	Dunmanway Rectory	4·03	102
,,	Mansfield, West Bank	2·00	51	,,	Mitchelstown Castle	1·85	47
VIII.	Nantwich, Dorfold Hall	1·87	47	,,	Gearahameen	7·40	188
,,	Bolton, Queen's Park	3·32	84	,,	Darrynane Abbey	3·72	95
,,	Lancaster, Strathspey	2·38	61	,,	Cashel, Ballinamona	1·39	35
IX.	Wath-upon-Dearne	1·44	37	,,	Roscrea, Timoney Pk.	1·94	49
,,	Bradford, Lister Park	2·53	64	,,	Ballybunion	2·16	55
,,	West Witton	3·04	77	,,	Broadford, Hurdlesto'n	2·35	60
,,	Scarborough, Scalby	3·31	84	XXI.	Kilkenny Castle	1·12	28
,,	Middlesbro', Albert Pk.	1·44	37	,,	Rathnew, Clonmannon	1·64	42
,,	Mickleton	2·30	58	,,	Hacketstown Rectory	1·96	50
X.	Bellingham	2·45	62	,,	Balbriggan, Ardgillan	1·48	38
,,	Ilderton, Lilburn	1·92	49	,,	Drogheda	1·37	35
,,	Orton	4·85	123	,,	Athlone, Twyford	1·80	46
XI.	Llanfrechfa Grange	..	..	XXII.	Castle Forbes Gdns.	2·00	51
,,	Treherbert, Tyn-y-waun	9·06	230	,,	Ballynahinch Castle	4·08	104
,,	Carmarthen Friary	..	..	,,	Galway Grammar Sch.	1·71	43
,,	Lampeter, Falcondale	3·49	89	XXIII.	Westport House	3·43	87
,,	Cray Station	8·50	216	,,	Enniskillen, Portora	1·84	47
,,	B'ham W.W., Tyrmyndd	4·87	124	,,	Armagh Observatory	1·35	34
,,	Lake Vyrnwy	5·10	129	,,	Warrenpoint	2·01	51
,,	Llangynhafal, P. Drâw	2·96	75	,,	Belfast, Cave Hill Rd.	1·65	42
,,	Oakley Quarries	6·41	163	,,	Glenarm Castle	2·10	53
,,	Dolgelly, Bryntirion	3·95	100	,,	Londonderry, Creggan	2·27	58
,,	Snowdon, L. Llydaw	..	..	,,	Sion Mills	2·03	52
,,	Lligwy	2·28	58	,,	Milford, The Manse	1·87	47
XII.	Stoneykirk, Ardwell Ho.	1·44	37	,,	Narin, Kiltoorish	2·51	64
,,	Carsphairn, Shiel	3·21	81	,,	Killybegs, Rockmount	3·92	100

Correction—Clifton College, February, for "3·81/97" read "4·59/117."

Climatological Table for th

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean M.S.L.	Diff. from Normal	Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	°F.		°F.		°F.	°F.	°F.	°F.
London, Kew Observatory	1022·1	+8·4	83	5	35	25	66·4	46·0	56·2	+6·3
Gibraltar	1017·7	+2·5	81	1	57	27, 28	74·1	65·7	69·9	+3·2
Malta	1019·5	+3·8	81	12	63	24, 30	74·7	66·6	70·7	+0·8
Sierra Leone	1012·0	+0·1	91	2, 12, 18	70	30	87·5	73·7	80·6	+0·4
Lagos, Nigeria	1012·6	+0·9	88	10	71	2	85·9	74·9	80·4	+1·3
Kaduna, Nigeria	1014·1	+1·8	93	30	60	8, 12	88·6	64·6	76·6	−1·1
Zomba, Nyasaland	1011·1	+0·6	91	14	56	1	85·6	63·6	74·6	+0·5
Salisbury, Rhodesia	1010·2	−0·8	92	27, 28	48	8, 9	87·0	55·6	71·3	+0·5
Cape Town	1019·0	+1·6	82	18	44	11	68·4	51·2	59·8	−1·2
Johannesburg	1013·7	+0·4	83	26	45	15	74·5	53·1	63·8	+1·2
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	92	26	40	12	80·8	50·5	65·7	+1·1
Calcutta, Alipore Obsy.	1011·0	+1·6	91	6	63	31	86·4	73·4	79·9	−0·8
Bombay	1010·0	+0·3	91	19	73	31	89·3	77·3	83·3	+1·0
Madras	1009·4	+0·5	93	6	72	8	86·0	75·0	80·5	−1·6
Colombo, Ceylon	1009·9	+0·1	89	4	73	19	86·3	75·2	80·7	+0·2
Hong Kong	1015·9	+2·3	86	23	69	31	81·0	72·3	76·7	−0·2
Sandakan	..	..	90	14, 16	72	25	87·0	74·7	80·9	−0·6
Sydney	1015·8	+0·9	85	31	49	23	70·1	53·5	61·8	−1·7
Melbourne	1015·8	+1·2	86	30	39	7	66·2	48·6	57·4	−0·2
Adelaide	1016·5	+0·4	98	29	41	4	73·4	52·6	63·0	+1·1
Perth, Western Australia	1015·8	−1·0	81	2	41	20	69·5	52·1	60·8	−0·2
Coolgardie	1014·0	−1·2	90	23	37	14	76·6	50·6	63·6	0·0
Brisbane	1016·3	+0·1	85	22	51	3	77·2	58·0	67·6	−2·1
Hobart, Tasmania	1012·9	+2·3	81	25	36	6	61·0	44·9	52·9	−1·1
Wellington, N.Z.	1012·2	−0·1	66	7	42	27	59·6	50·2	54·9	+0·6
Suva, Fiji	1014·3	+1·1	86	22	63	2	84·6	68·3	76·5	+0·5
Kingston, Jamaica	1012·0	+0·1	92	3	68	30	88·1	72·7	80·4	−0·1
Grenada, W.I.	1008·8	−2·2	90	30	71	10	84·2	74·5	79·3	−0·8
Toronto	1014·2	−3·8	72	1	33	13	58·9	41·8	50·3	+3·4
Winnipeg	1013·2	−2·1	76	4	26	7	54·8	37·5	45·3	+4·5
St. John, N.B.	1012·2	−4·3	71	2	24	26	56·4	41·3	48·9	+3·6
Victoria, B.C.	1015·9	−1·7	73	10	39	23	56·6	45·6	51·1	+0·7

LONDON, KEW OBSERVATORY.—Mean speed of wind 4·6 mi/hr; 15 days with fog.

GIBRALTAR.—2 days with thunder heard.

MALTA.—Prevailing wind direction E. Hours of obs. from this month are 7 h. and 18 h.

SIERRA LEONE.—Prevailing wind direction SW; 7 days with thunder heard.

LAGOS.—Harmattan appeared on 26th.

SALISBURY, RHODESIA.—1 day with thunder heard.

THAMES VALLEY RAINFALL —— MARCH, 1922.

H.M. Stationery Office Press, Kingsway, W.C.2

Pa. 1693/209. 75. 63. D.P.S. 1922. 4/22.

British Empire, October 1921.

TEMPERATURE				PRECIPITATION				BRIGHT SUNSHINE		STATIONS
Mean	Absolute	Relative Humidity	Mean Cloud Am'nt	Amount		Diff. from Normal	Days	Hours per day	Percentage of possible	
Wet Bulb.	Min. on Grass									
°F.	°F.	%	0–10	in.	mm.	mm.				
53·5	27	77	5·1	0·44	11	− 58	7	4·9	46	London, Kew Observatory.
67·4	50	90	5·4	1·07	27	− 57	6	..	..	Gibraltar.
64·9	56	70	4·2	0·67	17	− 51	7	7·8	69	Malta.
75·7	..	75	5·6	5·31	135	−189	17	..	..	Sierra Leone.
75·5	69	83	8·8	3·74	95	−101	15	..	..	Lagos, Nigeria.
69·8	..	71	..	2·56	65	+ 5	7	..	..	Kaduna, Nigeria.
..	..	73	2·8	2·31	59	+ 21	6	..	..	Zomba, Nyasaland.
59·3	..	43	4·2	1·30	33	+ 3	5	..	..	Salisbury, Rhodesia.
55·6	..	63	4·8	1·21	31	− 13	11	..	..	Cape Town.
53·0	46	58	4·2	2·88	73	+ 12	9	8·6	68	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
53·7	..	47	4·8	0·49	12	− 31	5	..	..	Bloemfontein.
74·6	57	60	4·6	0·29	7	− 92	0*	..	..	Calcutta, Alipore Obsy.
76·2	59	69	2·8	0·06	2	− 45	2*	..	..	Bombay.
76·5	..	89	7·8	24·34	618	+332	18*	..	..	Madras.
77·3	71	72	8·5	8·44	214	−143	26	..	..	Colombo, Ceylon.
69·0	..	69	3·6	0·39	10	−115	4	8·5	74	Hong Kong.
76·8	..	84	..	12·51	318	+ 64	17	..	..	Sandakan.
56·7	40	62	4·3	3·10	79	+ 4	13	7·6	59	Sydney.
53·2	35	64	5·6	3·66	93	+ 27	13	..	..	Melbourne.
54·2	34	50	5·2	1·81	46	+ 2	11	7·3	57	Adelaide.
56·1	41	63	4·9	2·62	67	+ 13	13	8·2	..	Perth, Western Australia.
54·1	35	36	5·1	1·30	33	+ 14	4	..	..	Coolgardie.
61·4	45	59	3·9	1·36	35	− 34	9	..	..	Brisbane.
47·8	30	64	5·9	0·94	24	− 33	15	..	..	Hobart, Tasmania.
51·8	33	80	7·8	6·48	165	+ 58	18	4·4	33	Wellington, N.Z.
77·0	..	97	..	4·91	125	− 73	15	..	..	Suva, Fiji.
..	..	77	5·8	4·15	105	− 85	10	..	..	Kingston, Jamaica.
75·5	..	80	4·7	12·04	306	+120	24	..	..	Grenada, W.I.
44·5	28	82	5·5	4·46	113	+ 51	14	..	..	Toronto.
41·0	..	67	4·9	0·93	24	− 14	10	..	..	Winnipeg.
44·8	21	83	5·2	2·47	63	− 52	10	..	..	St. John, N.B.
47·0	29	81	5·7	4·74	120	+ 55	14	..	..	Victoria, B.C.

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

MADRAS.—13 days with thunder heard.

COLOMBO, CEYLON.—Prevailing wind direction WSW, mean speed 4·1 mi/hr. 3 days with thunder heard.

HONG KONG.—Prevailing wind direction E, mean speed 11·4 mi/hr.

SUVA, FIJI.—1 day with thunder heard.

GRENADA, W.I.—Prevailing wind direction E; 1 day with thunder heard.

(*Continued from p.* 83.)

period 1886–1917 no cyclone travelled as far west as the mouth of the Zambesi during any month and none reached the coast in February.

The rainfall of the month was again below the average generally, although the actual distribution of rainfall was normal in type, especially, in England, where only small areas had rainfall differing from the average by more than 20 per cent. In Shropshire, Hereford and the Devon–Cornwall peninsula more than 20 per cent. in excess was recorded. The area with rainfall above the average was mainly in the south-west of England and Wales and along the east and south coasts from about Boston to Hastings. Less than the average occurred in the centre and north of England and Wales, but nowhere was the deficiency large. In Ireland the distribution of rainfall was normal, but the amount was everywhere deficient. Less than half the average was recorded in the extreme south-east, and the eastern half generally had less than 75 per cent. of the average. In Scotland there was a small deficiency nearly everywhere, but the fall was apparently nowhere less than half the average. The month was not conspicuous for any very heavy falls on one day. The number of rain days was practically everywhere more than 10, by far the greater part of the country having more than 15 days with rain.

The general rainfall for March, expressed as a percentage of the average was:—England and Wales, 103; Scotland, 76; Ireland, 72; British Isles, 86.

In London, Camden Square, the mean temperature for March was 41·8° F., or 0·3° F. below the average; the duration of rainfall, 42·2 hours; and the evaporation, ·96 inch.

News in Brief.

We regret to announce the death on April 2nd of Dr. H. N. Dickson, sometime Professor of Geography at University College, Reading, and formerly President of the Royal Meteorological Society. It is hoped to publish an obituary notice in the May number of the Magazine.

The Bergen Museum has equipped a vessel, the *Arnauer-Hansen*, for deep-sea exploration in the Atlantic. The expedition will start at the end of April under the leadership of Professor Helland-Hansen.

Erratum.—With reference to the note on *Frequency of Fog in the English Channel*, published last month, pp. 47 and 48, it should be stated that Longships is a lighthouse, not a light-vessel.